

Sub-picosecond streak cameras

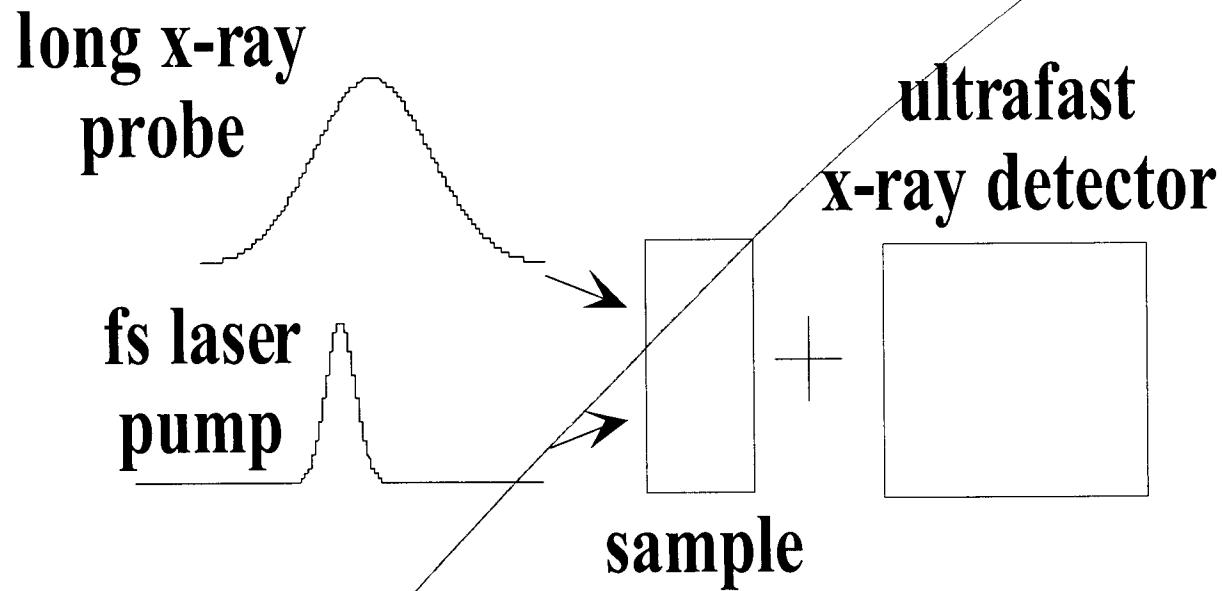
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OUTLINE

- **Context**
- **Sub-picosecond streak designs**
- **Jitter free systems**
- **perspectives**

Synchrotron Source



- *2D information*
- *limit on temporal resolution ?*
- *dynamic range ?*

The X-ray challenge

- 1988 2ps resolution (*Berkeley, APL, 56, 1948, 1990*)
- 1993 900fs resolution (*LLNL, RSI, 66, 719, 1995*)
- 1996 500fs resolution (*Xian, SPIE, 2869, 971, 1996*)
- 1999 350fs resolution (*INRS, RSI, 71, 3627, 2000*)

INRS

Temporal resolution

$$\Delta t = 3 \times 10^{-8} (\varepsilon)^{1/2} / E_{\text{extr}}$$

ε width of the photoelectron distribution in eV

E_{extr} extraction field in V/cm

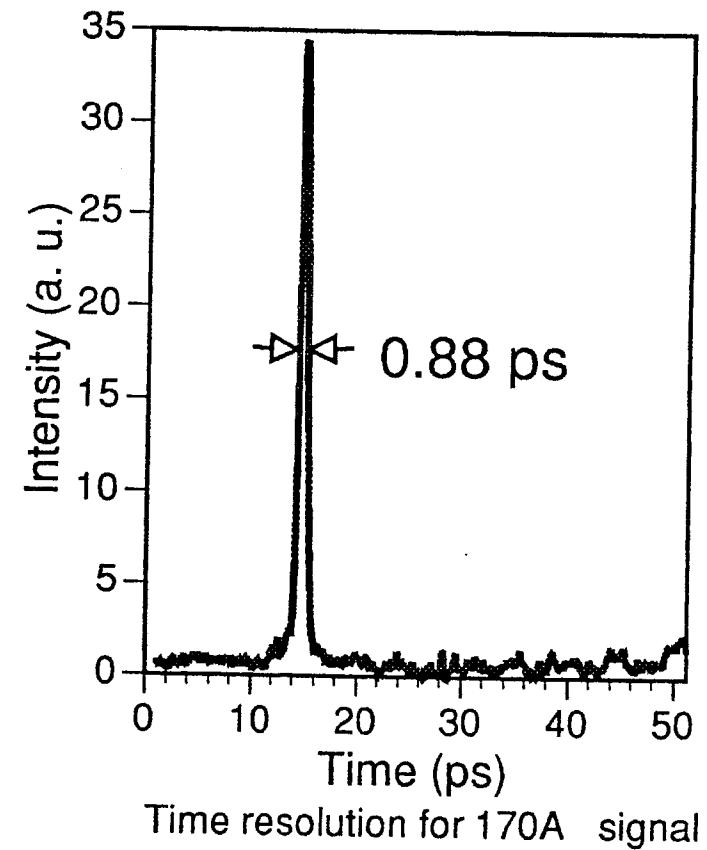
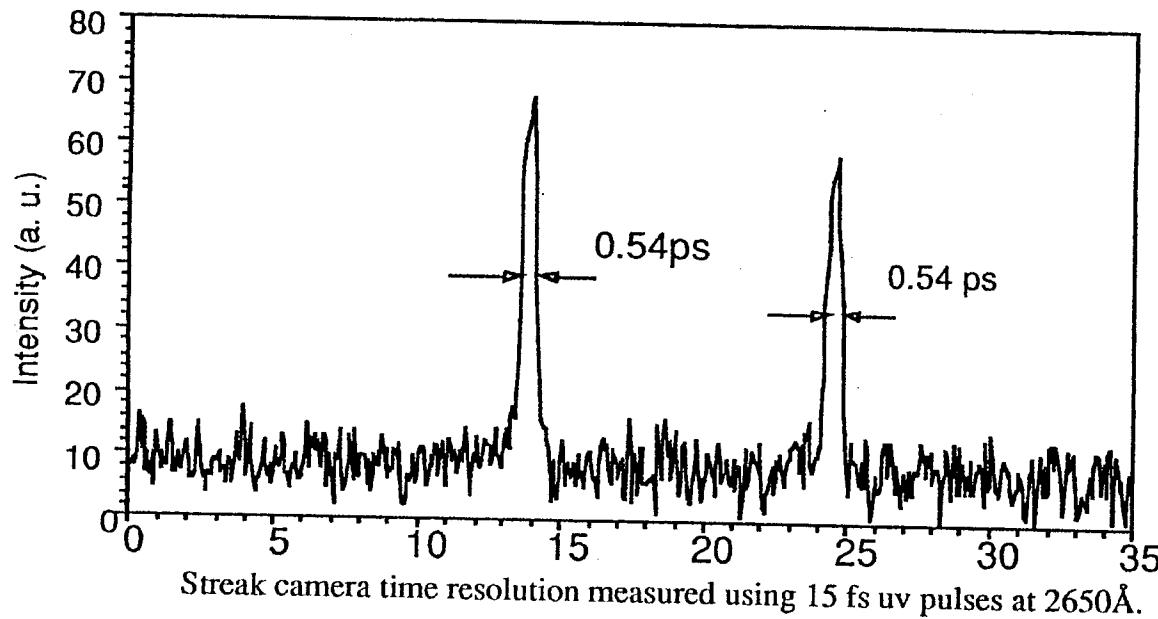
INRS

The Xian sub-picosecond camera

Magnetic lens

Deflection by travelling waves before lens

transit time dispersion minimized



INRS

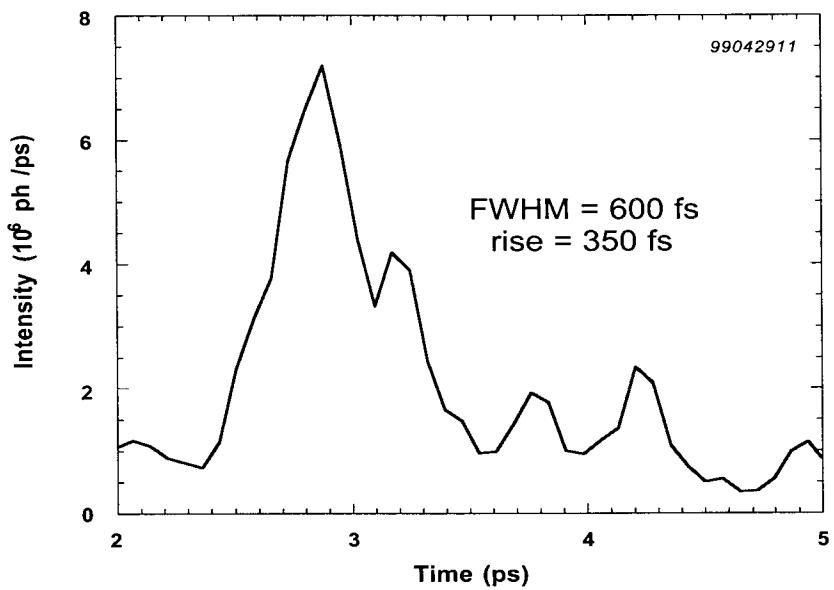
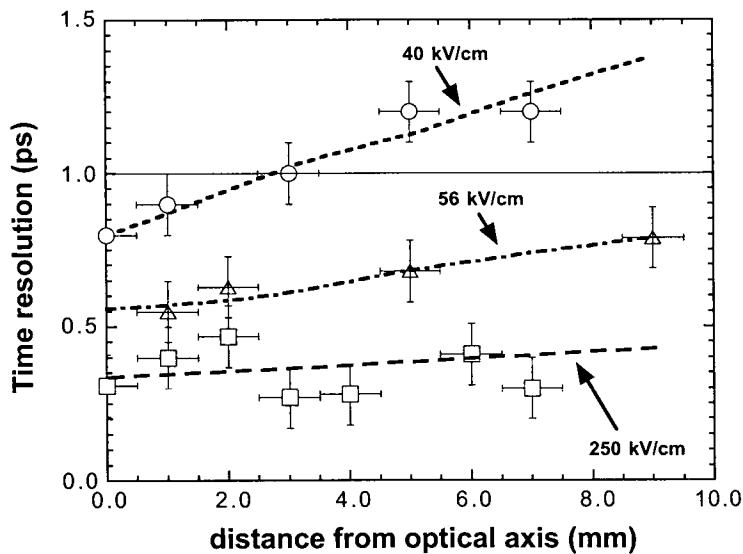
The PX1 sub-picosecond camera

Quadrupole lens

Paraxial electron trajectories

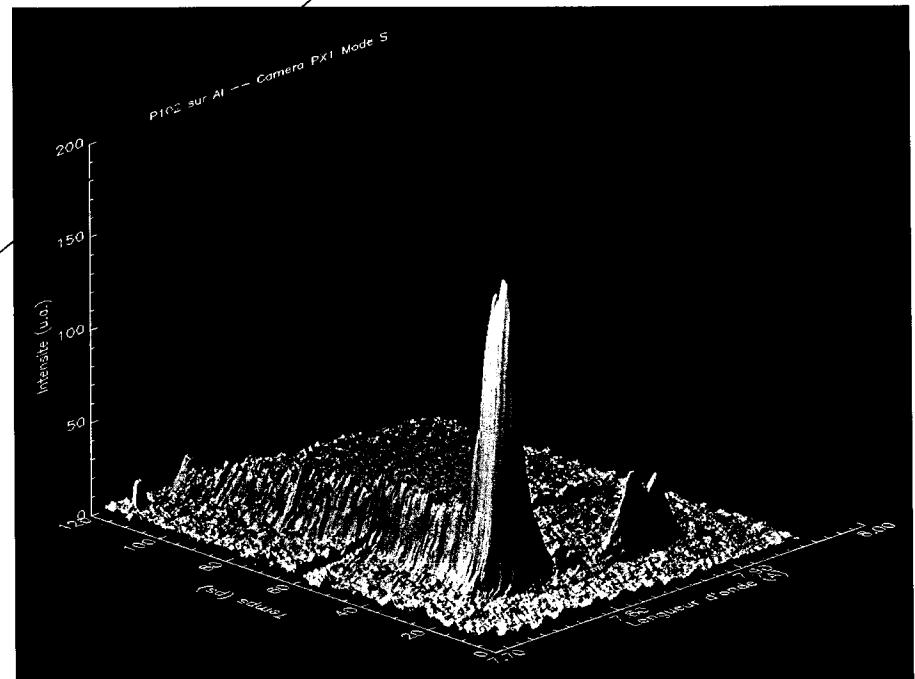
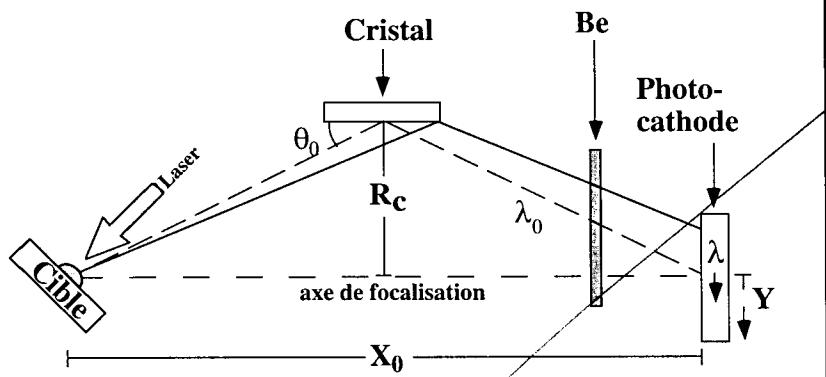
smaller aberrations, tight focus, no point crossover

Time resolution is 350fs with 2 keV x-rays



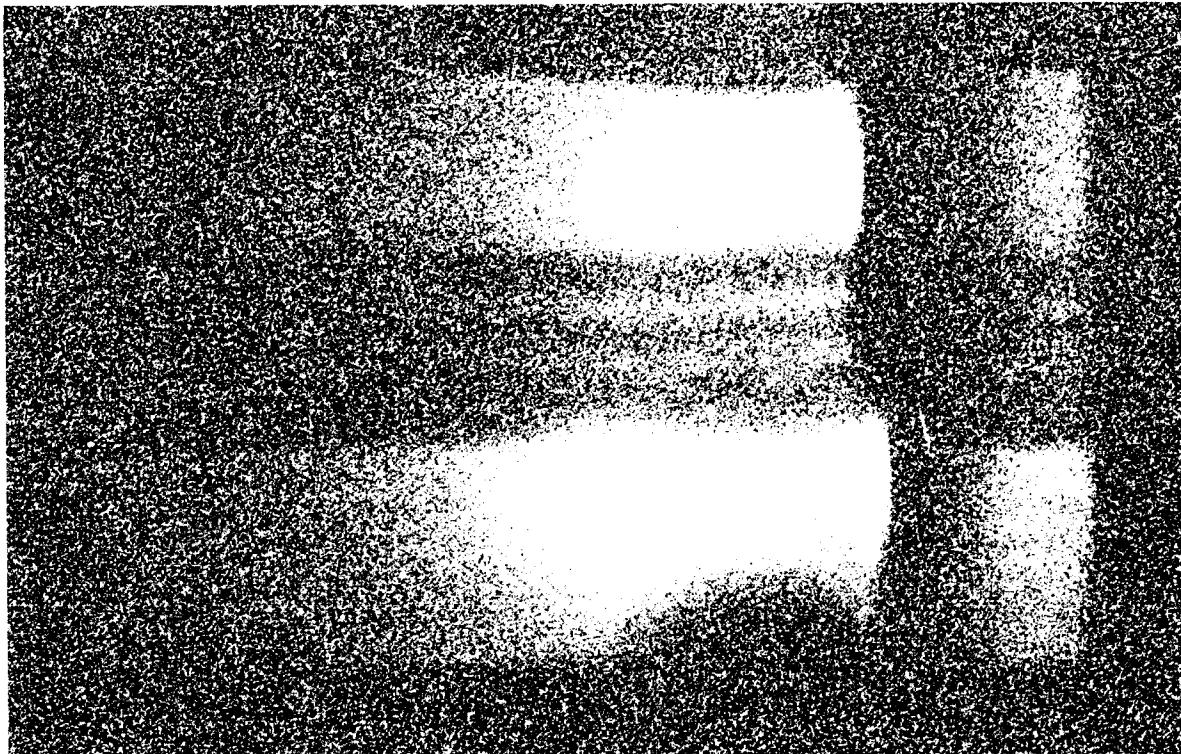
INRS

Spectroscopy of laser produced plasmas



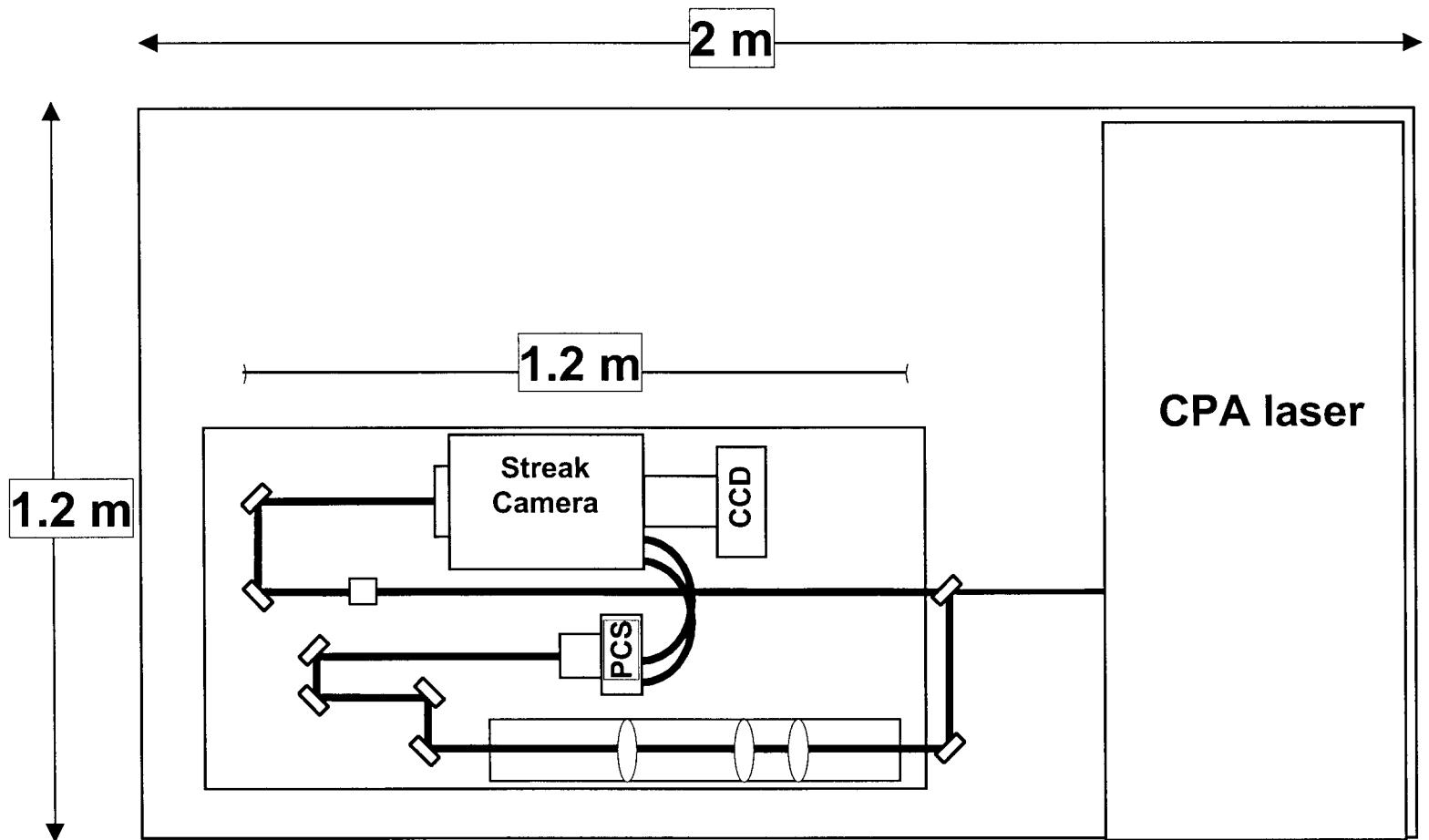
INRS

**Dynamical range is a problem in
single shot**

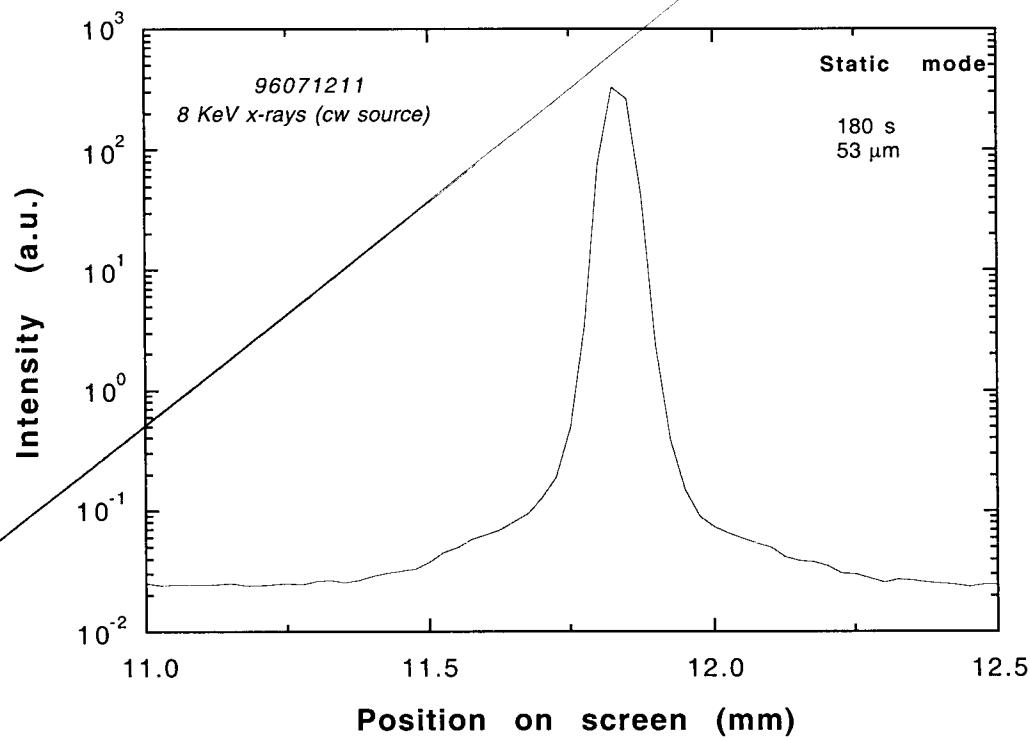


INRS

Jitter free system



Line spread function may limit large dynamic range

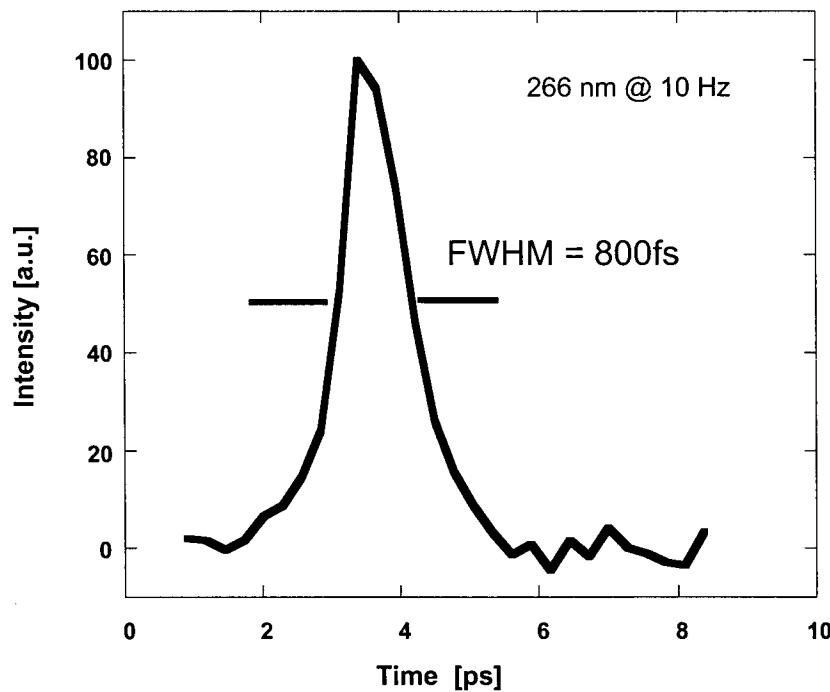


INRS

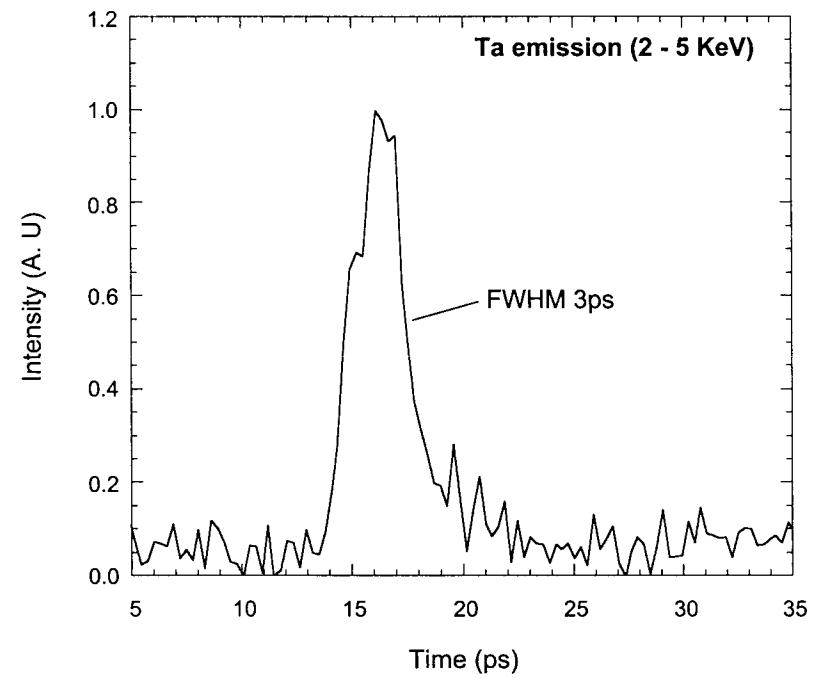
Laser + streak

Dalhousie univ.(1KHz), Garching (10Hz), INRS (10Hz), UCSD(20Hz)

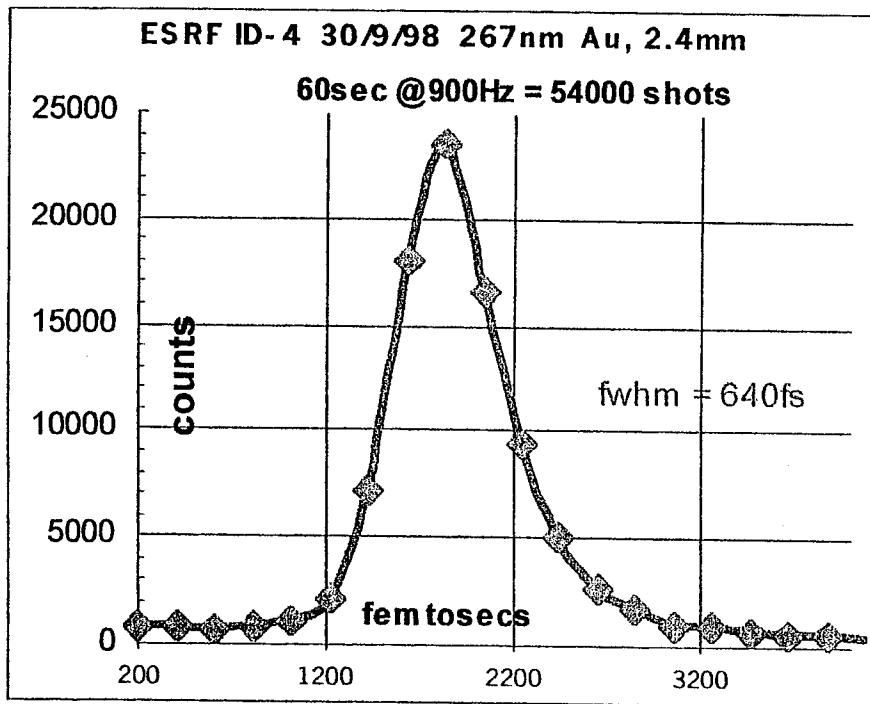
**300 shots, UV light
INRS**



**2000 shots, 2-5keV x-rays
UCSD**



1KHz laser + x-ray streak at ESRF



Conclusions/perspectives

- Streak *350fs resolution* —→ *200fs*
- Laser + streak *600fs resolution* —→ *300fs*
- Synchrotron + laser (*APS + Mich. Group*)
- Synchrotron + laser + X-ray streak
(*ALS +Berkeley group*)

Issue of the sensitivity of streak for some applications